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CLAIMS

1. A method of manufacturing a lateral microsolenoid in which a section of a lateral spiral coil formed on a substrate is divided into two parts, an upper half and a lower half, and
5 in which these are formed by the following steps A to D, the method comprising

a step A of coating a photosensitive material on said substrate, exposing and developing the photosensitive material using a mask in which a light-shielding film is present
10 outside a rectangular pattern and is absent thereinside, to transfer the rectangular pattern onto the photosensitive material and remove the photosensitive material inside the rectangular pattern, and then isotropically etching a portion in which the substrate surface in the region of the rectangular
15 pattern with the photosensitive material removed is exposed to form a sectional shape of a rectangular groove on a semicircular lower half,

a step B of forming a metal wiring of a lower half of the spiral coil on the groove portion formed in said step A,

20 a step C of stacking an insulating material on the metal wiring formed in said step B such that the section constituting the inside portion of the spiral coil becomes equal to the diameter of the circle, further coating a photosensitive material of a thickness which becomes equal to the radius of
25 the inside portion having the circular section, exposing and

developing said photosensitive material using a mask in which a light-shielding film is present inside the rectangular pattern and is absent thereoutside, and the short-side width of the rectangular pattern is equal to the diameter of the circle of the section constituting the inside portion of the spiral coil, to transfer the rectangular pattern onto the photosensitive material and remove the photosensitive material outside the rectangular pattern, then of forming the sectional shape of the photosensitive material on the circular upper half by heat-melting, and then etching the undercoat material along with the photosensitive material by dry etching, and transferring the sectional shape of said photosensitive material onto the undercoat material to form a cylindrical portion that becomes an inside portion of the spiral coil with the insulating material inside the metal wiring formed on said lower half, and

a step D of forming a metal wiring of an upper half of the spiral coil on the outer peripheral surface of the cylindrical portion formed in said step C.

2. A method of manufacturing a lateral microsolenoid in which a section of a lateral spiral coil formed on a substrate is divided into two parts, an upper half and a lower half, and in which are formed by the following steps A to D, the method comprising

a step A of coating a photosensitive material on said

substrate, exposing and developing said photosensitive material using a mask A to form the sectional shape of the photosensitive material on a lower half of a complete circle, then etching an undercoat material along with said
5 photosensitive material by dry etching to transfer the sectional shape of the photosensitive material onto the undercoat material and thereby form the sectional shape of the groove on the lower half of the complete circle,

a step B of forming a metal wiring of the lower half
10 of the spiral coil on the groove portion formed in said step A,

a step C of stacking an insulating material on the metal wiring formed in said step B such that the section constituting the inside portion of the spiral coil becomes equal to a
15 diameter of a complete circle, further coating a photosensitive material of a thickness with which the section becomes equal to the radius of the inside portion of the complete circle, and of conducting exposure and development using a mask B to form a cylindrical portion which becomes an inside portion of
20 the spiral coil with an insulating material inside the metal wiring formed on the lower half, and

a step D of forming a metal wiring of an upper half of the spiral coil on the outer peripheral surface of the cylindrical portion formed in said step C,

25 said mask A being such that, in order to form a groove

having a section of a half of a complete circle on the substrate, a light-shielding film having a light transmittance of 0% for a portion outside a groove width and a light-shielding film capable of continuously controlling a light transmittance from 0% to 100% with the inside of the light-shielding film having the light transmittance of 0% directed toward the center which is the deepest position of said groove, are provided on a glass through which a light is transmitted by 100%, and the mask B having light-shielding films capable of controlling the light transmittances in an inverse relation to the light transmittances of said mask A in order to form such that it protrudes, the cylindrical portion having the section of the half of the complete circle on the substrate using the insulating material.

3. A method of manufacturing a longitudinal microsolenoid, which comprises

a step A of stacking an insulating material on a substrate, coating a photosensitive material thereon, and exposing and then developing the photosensitive material using a mask C to form a spiral photosensitive material,

a step B of, after said step A, solidifying the photosensitive material by treatment at a high temperature, forming an insulating material under the photosensitive material into a spiral shape by etching, and stacking a metal on the substrate,

a step C of, after said step B, coating a photosensitive material, and exposing and developing the photosensitive material using a mask D to leave the photosensitive material covering only the metal on the base of the spiral structure,

5 and

a step D of, after said step C, conducting high-temperature treatment, etching the metal that is exposed, and then removing the photosensitive material,

said mask C being such that a light-shielding film
10 capable of controlling a light transmittance from 100% to 0% annularly and continuously is provided on a glass through which a light is transmitted by 100%, and such that said mask D has an annular light-shielding film with a light transmittance of 0%.

15 4. A method of manufacturing a longitudinal microsolenoid, which comprises

a step A of stacking an insulating material on a substrate, coating a photosensitive material thereon, and exposing and then developing the photosensitive material using
20 a mask E to form an inclined photosensitive material,

a step B of, after said step A, conducting treatment at a high temperature, forming a semiconductor material of an inclined structure by etching, and stacking a metal on the whole surface of the substrate,

25 a step C of, after said step B, coating a photosensitive

material, and exposing and developing the photosensitive material using a mask F to leave the photosensitive material covering the metal on the inclined surface, and

5 a step D of, after said step C, conducting treatment at a high temperature, etching the metal that is exposed, and then removing the photosensitive material,

said mask E having a light-shielding film capable of continuously controlling a light transmittance with a fixed width, and said mask F having a semicircular light-shielding
10 film with a light transmittance of 0%.

5. A method of manufacturing a lateral microsolenoid in which a section of a lateral spiral coil formed on a substrate is divided into two parts, an upper half and a lower half, and in which these are formed by the following steps A to E, the
15 method comprising

a step A of stacking an insulating material on said substrate, coating a photosensitive material thereupon, exposing and developing said photosensitive material using a mask A to form the sectional shape of the photosensitive
20 material on a lower half of a complete circle, and then etching an undercoat material along with the photosensitive material by dry etching to transfer the sectional shape of said photosensitive material onto the undercoat material and thereby form the sectional shape of the groove on the lower
25 half of the complete circle,

a step B of forming a metal wiring of the lower half of the spiral coil on the groove portion formed in said step A,

5 a step C of stacking an insulating material on the metal wiring formed in said step B, such that the section constituting the hollow portion of the spiral coil becomes equal to a diameter of a complete circle, further coating a photosensitive material of a thickness which becomes equal to the radius of the hollow portion having the section of the complete circle,
10 and conducting the exposure and the development using a mask B to form a cylindrical portion which becomes a hollow portion of the spiral coil with the insulating material inside the metal wiring formed on said lower half, and

a step D of forming a metal wiring of an upper half of
15 the spiral coil on the cylindrical portion formed in said step C, and

a step E of, after said step D, removing the insulating material on the substrate by isotropic etching, and separating the spiral coil from the substrate,

20 said mask A being such that, in order to form a groove having a section of a half of a complete circle on the substrate, a light-shielding film having a light transmittance of 0% for a portion outside a groove width and a light-shielding film capable of continuously controlling a light transmittance from
25 0 to 100% with the inside of the light-shielding film having

the light transmittance of 0% directed toward the center which is the deepest position of said groove, are provided on a glass through which a light is transmitted by 100%, and the mask B having light-shielding films capable of controlling the light transmittances in an inverse relation to the light transmittances of said mask A in order to form, such that it protrudes, the cylindrical portion having the section of the half of the complete circle on the substrate using the insulating material.

10 6. A method of manufacturing a longitudinal microsolenoid, which comprises

 a step A of stacking a first insulating material on a substrate, further stacking a second insulating material, coating a photosensitive material thereon, and exposing and
15 then developing the photosensitive material using a mask C to form a spiral photosensitive material,

 a step B of, after said step A, conducting treatment at a high temperature to solidify the photosensitive material, forming the first insulating material under the photosensitive
20 material into a spiral shape by etching, and stacking a metal on the first insulating material,

 a step C of, after said step B, coating a photosensitive material, and exposing and developing the photosensitive material using a mask D to leave the photosensitive material
25 covering only the metal on the base of the spiral structure,

a step D of, after said step C, conducting treatment at a high temperature, etching the metal that is exposed, and then removing the photosensitive material, and

5 a step E of, after said step D, removing the first insulating material on the substrate by isotropic etching, and separating the spiral coil from the substrate,

said mask C being such that a light-shielding film capable of controlling a light transmittance from 100% to 0% annularly and continuously is provided on a glass through which
10 a light is transmitted by 100%, and such that said mask D has an annular light-shielding film with a light transmittance of 0%.

7. A method of manufacturing a longitudinal microsolenoid, which comprises

15 a step A of stacking a first insulating material on a substrate, further stacking a second insulating material, coating a photosensitive material thereon, and exposing and then developing the photosensitive material using a mask E to form an inclined photosensitive material,

20 a step B of, after said step A, conducting treatment at a high temperature, forming a second insulating material of an inclined structure by etching, and stacking a metal on the whole surface of the substrate,

a step C of, after said step B, coating a photosensitive
25 material, and exposing and developing the photosensitive

material using a mask F to leave the photosensitive material covering only the metal on the inclined surface,

a step D of, after said step C, conducting treatment at a high temperature, etching the metal that is exposed, and
5 then removing the photosensitive material, and

a step E of, after said step D, removing the first insulating material on the substrate by isotropic etching, and separating the spiral coil from the substrate,

said mask E being such that a light transmittance is
10 continuously changed from one side to an opposite side of a rectangular shape, and such that mask F has a semicircular light-shielding film with a light transmittance of 0%.

8. A microsolenoid manufactured by the method as claimed in any one of claims 1 to 7.